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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of)
Advanced Television Systems)
and Their Impact upon the)
Existing Television Broadcast)
Service)

MM Docket No. 87-268

REPLY COMMENTS OF ZENITH ELECTRONICS CORPORATION

These comments of Zenith Electronics Corporation reply to select-
ed comments in response to the Commission's Second Report and
Order/Further Notice of Proposed Rule Making ("Further Notice") relat-
ed to the selection of a high-definition television (HDTV) system for
the United States.

As in the Commission's original Notice, the comments reflect the
continuing high level of interest in these proceedings and in the work
of the Commission and its Advisory Committee on Advanced Television
Services. Zenith commends the Commission and the Advisory Committee
in this undertaking.

Zenith's reply comments address the availability and cost of
equipment, the vacating of NTSC channels, maximum field strength and
technical developments. Many of our comments correct misconceptions
about progressive scan and production standards issues.

AVAILABILITY AND COSTS OF EQUIPMENT

Some comments in response to the Further Notice are again attempting to gain support for the production standard having 1035 active lines (interlaced) and a 60-frame-per-second refresh rate (the 1125/60/2:1 Japanese-originated standard). Sony Corporation of America (Sony) bases its argument on worldwide economies of scale, picture resolution, timely availability of equipment and, of course, their own substantial investment.

1. Economies of Scale

There have been previous attempts on the part of Sony and other Japanese entities to establish the 1125/60/2:1 system as a worldwide production standard through the CCIR. The European Community has rejected these bids because of the unfriendliness of the number of scanning lines (there is no simple integer relationship¹ between 1125 and 1250), the different frame rates (60 versus 50 Hz) and their desire to have a unique European format. In the United States, it has been the general consensus to postpone the selection of a production standard until the HDTV transmission standard is selected. It is highly unlikely that the European Community will pick a scanning standard that does not have a simple integer relationship to their

¹Electronic circuitry for format conversion is considerably simpler and less costly with formats that are related by simple number ratios such as 2:1 and 3:2.

existing 625-line, 50 Hz system, and it is even more unlikely that the U.S. HDTV transmission system will be 1125-related, so the likelihood of a worldwide 1125/60/2:1 production standard is very small.

On the other hand, given the selection of an NTSC-friendly HDTV transmission system in the U.S., there is an opportunity for a common worldwide standard that does have simple integer relationships with both existing and future HDTV European and U.S. standards. Such a digital standard has been proposed as a "common image format" with 1080 active lines and 1920 horizontal pixels. This format has simple integer relationships² with the U.S. proposed HDTV formats of 787.5 (720 active) and 1050 (960 active) lines, the European HDTV format of 1250 (1152 active) lines, the NTSC format of 525 (480 active) lines, and the European PAL/SECAM formats of 625 (576 active) lines. Also, the 1920-by-1080 ratio is exactly 16-by-9 which yields square pixels with the universally accepted 16:9 HDTV aspect ratio. The potential for the 1080-by-1920 common image format is being actively pursued by the Advanced Television Systems Committee.

²3:2 for 787.5 and 9:8 for 1050. (For similar reasons, Zenith chose the simple 3:2 ratio between the Zenith/AT&T system's 787.5 progressive scan format and the 525 NTSC scan format.)

2. Picture Resolution

Sony (page 22) points to "a dramatic shortfall of more than 1 million pixels" in the 787.5 line, 59.94 Hz progressively scanned format chosen by two of the four U.S. digital proponents. The 787.5 format has 720 active lines and 1280 horizontal pixels in each 1/60 of a second. It is extremely misleading to compare the number of pixels scanned or displayed by the 1125/60/2:1 system in 1/30 of a second to the number of pixels scanned or displayed by the 787.5 progressive standard in 1/60 of a second. The number of pixels scanned or displayed during equal time frames is essentially the same.³

The real trade-off in resolution between 787.5 progressive and 1125 interlace (or 1050 interlace, for that matter) is the difference between temporal resolution and spatial resolution. While the interlaced systems have greater spatial (horizontal and vertical) resolution, the progressive system has double the temporal resolution or motion rendition performance. The increased spatial resolution may have some slight advantage when viewing extremely high-resolution stills⁴ such as satellite reconnaissance photos, but the progressively

³It is this essential equality in pixel and bit rates which makes the recording of the 787.5 progressive format possible on the 1125 interlaced HD recorder through the use of the format converter designed by the Advanced Television Test Center.

⁴Zenith and AT&T have publicly demonstrated 787.5 progressive pictures on very large projection systems to tens of thousands of viewers. Even with extremely complex still scenes, concerns have not been made as to the adequacy of the spatial resolution.

scanned and displayed fast motion scenes are far superior.⁵

As Sony suggests (at page 35), "[t]hree program types enjoy wide appeal in the U.S: sports, movies, and special events."⁶ Accurate portrayal and enjoyment of sports and special events require the fast motion rendition of progressive scan. In today's 24-frame-per-second movies, fast human-vision-trackable motion is carefully controlled by the technical director. Surely, movie directors would prefer to be able to capture fast motion accurately.

3. Timely Availability of Equipment

Sony contends that 1125/60/2:1 studio equipment is the only readily available equipment and that development and deployment of studio equipment in the 787.5 progressive format will be more expensive and delay HDTV implementation and penetration.

There is no fundamental technological barrier to studio equipment associated with the 787.5 progressive format.

⁵Zenith and AT&T public demonstrations have incorporated fast, highly-complex motion scenes to show the benefits of improved temporal rendition. Materials selected by proponents of interlaced systems have generally avoided complex motion sporting events.

⁶Special events, per Sony (page 36), "such as Olympic games, major golf tournaments, boxing bouts, rock concerts, horse races..."

Tube cameras in the 787.5 format exist. Our investigations suggest that charge coupled device (CCD) imagers for cameras and film transfer are feasible. In fact, Sony suggests (at page 21) that "[c]learly, a CCD imager could be developed with 1280 horizontal pixels and 720 rows and the high sampling frequency required to sustain the real-time 787.5 progressive scan system -- using this same technology."

Baseband high-definition digital recorders exist and are being used (with the help of an external format converter) by Zenith, AT&T, GI/MIT, ATTC, ATEL and CableLabs to record and playback the 787.5 progressive format. Modification of current equipment for direct recording and playback of 787.5 baseband will not be difficult, and when there is demand, we expect equipment manufacturers to respond.

It should also be recognized that, regardless of the transmission format and production standard ultimately employed, much of the studio processing can be done by recording the partially compressed bit stream (say, 100 to 200 Mb/s) utilizing the existing and substantially less costly D-1, D-2 and D-3 digital recording equipment.

It is clear that many studio equipment manufacturers are awaiting the selection and emergence of the U.S. transmission standard prior to committing to build equipment in any new HDTV standard. It is our firm belief that this transition will be rapid once the transmission system choice is clear. Moreover, the entrance into the studio equipment marketplace by several companies to meet the Commission-imposed implementation timetable will result in competitive forces to ensure

cost-effective and timely availability. This, of course, is consistent with the prudent approach taken by the Commission to allow testing and evaluation under the auspices of the Advisory Committee to determine the transmission format and then the production format, rather than issuing a directive.

4. Benefits of Progressive Scan

In addition to the substantially improved temporal resolution and more than adequate spatial resolution mentioned above, the 787.5 progressive standard has many other benefits compared to interlaced standards:

- Computer synthesis/processing and production are greatly facilitated by progressive scanning and square pixels.
- Interoperability with multi-media computing and other applications is considerably easier with a progressive transmission standard.
- Format conversions are facilitated by the progressive format -- for both home-entertainment and non-entertainment applications -- due to the lack of temporal artifacts inherent with interlace conversion.

- Addressability of matrixed flat-panel display elements for future high-definition projection systems requires progressive scanning due to excessive smear with 30 Hz refresh rates.⁷

5. U.S. Production Standard

Recognizing the need for a U.S. production standard to support a 787.5 progressive or 1050 interlaced transmission standard, the aforementioned 1080 active lines by 1920 horizontal pixels common image format has been discussed and, at the urging of PBS, has been proposed to the ATSC. It is clear that an ultimate production standard should be of the progressive scan type. Thus, the proposal to ATSC is for 1080-by-1920 progressive with an interim proposal for 1080-by-1920 interlace, which recognizes the potential near-term lack of progressive scan equipment. Scan-conversion to and from 787.5 is easily achievable. Modification of existing 1125 (1035 active lines) equipment to handle the 1080 line structure also is believed to be easily

⁷Japanese Technology Evaluation Center (JTEC) Panel Report on Display Technologies in Japan, June 1992, pp. 119-129 (section on Projection Displays, authored by William E. Glenn). JTEC is operated for the U.S. Federal Government. Sponsors are the National Science Foundation, the National Aeronautics and Space Administration, the Department of Commerce, the Department of Energy, the Office of Naval Research, the Defense Advanced Research Projects Agency and the U.S. Air Force.

achieved. Nevertheless, to assure that materials already existing in the 1125/60/2:1 format can be used in conjunction with the 787.5 progressive format, Zenith and AT&T have successfully demonstrated⁸ the conversion of 1125 interlaced material to the 787.5 progressive format.

VACATING OF NTSC CHANNELS

The Land Mobile Communications Council (page 5, paragraph 8) suggests immediate vacating of any NTSC channel once a given licensee has made the transition to HDTV. Similarly, the National Telecommunication and Information Administration (pages 11 and 4) suggests broadcasters should choose whether to offer NTSC or HDTV and surrender the unwanted channel "at any time."

Release of an NTSC channel prior to a common mandated date is contrary to our understanding of the Commission's and the television industry's desire to continue to serve the existing NTSC receivers. We urge the Commission to hold firm in its NTSC-to-HDTV transaction plans.

⁸National Association of Broadcasters Convention, April 1992, and over-the-air terrestrial broadcast, Milwaukee, Wisconsin, to Glenview, Illinois, May 1992.

MINIMUM FIELD STRENGTH

General Instrument Corporation (GI) suggests (at page 4) that a minimum field strength signal over the entire principal community to be served (such as that specified in 47CFR §73.685 for NTSC transmission) may not be applicable for HDTV. Assuming the selection of a digital HDTV system, the transmitted power and the resultant field strength can be about one-tenth of that required for comparable coverage with analog NTSC transmission. To assure reliable reception, a reduced but minimum field strength should be required over the entire principal service community.

The elimination of a minimum field strength rather than a reduction of that minimum (relative to NTSC) is not in the public interest. A cellular approach would only be required if HDTV coverage were restricted because of a shortfall in preventing interference from NTSC transmissions in locations with comparable HDTV (desired) and NTSC (undesired) signal strengths. Furthermore, we do not believe that a cellular transmission approach would be economical for broadcasters (multiple transmitters, antennas and antenna sites) or consumers (antennas equipped with rotors).

The cellular approach should only be considered as a last alternative to aid channel allocation. (It is not required by the Zenith/AT&T DSC-HDTV proposal.)

TECHNICAL DEVELOPMENTS

We agree with the findings of the Advisory Committee in its Fifth Interim Report that there are no new developments that are sufficiently concrete to be contemporaneously tested.

Specifically, our review of technologies mentioned in response⁹ to the Further Notice indeed indicates neither "important new benefits" nor "concrete state of development." More specifically, the so-called Orthogonal Frequency Division Multiplex (OFDM) approach is not a new technology concept. This principle has been known since the 1960s as an approach to multipath problems.

Today, more practical and cost-effective¹⁰ solutions to channel equalization (ghost canceling) for video transmission are available, and are in fact implemented in the four digital systems currently under evaluation. It is surprising that this 8 MHz system suggested

⁹ Comments of Future Images Today, Quadratic Solutions, Inc., William F. Schreiber and Peter D. Symes.

¹⁰ In an HDTV receiver, the electronic complexity (which translates directly to silicon Integrated Circuit area and hence cost, of the channel equalizer will be about 10% of the total digital processing. On the other hand, the electronic complexity required to demodulate the 400-500 separate carriers required by an OFDM system at the speeds required for high-definition video is about 10 times that of the currently proposed HDTV channel equalizer. Thus, the receiver complexity of an OFDM system is estimated to be about double that of the proponent systems currently being tested.

in Europe is apparently advocated by some who have no modulation/transmission system experience and who have not prototyped (or even simulated) the performance. On the other hand, those with hands-on experience in this field, including Dr. Woo H. Paik¹¹ as well as Zenith's own staff, see no important new benefit of the OFDM for HDTV in a 6-MHz channel.

While there are no new technologies needing evaluation, the Commission should note the continued progress and improvements being made by the existing HDTV proponents. The Advisory Committee is making an effort to determine how to recognize the improvements to proponent system made after test. We support this action and believe it should become part of the recommendation process.

¹¹See Affidavit of Woo H. Paik appended to the GI submission.

CONCLUSION

These reply comments and our previous submissions under FCC Docket 87-268 reflect Zenith's continuing intense interest -- as a leading color television and picture tube manufacturer and as an HDTV system proponent (together with AT&T) -- in these proceedings. Zenith continues to support fully the Commission and its Advisory Committee in its goals of implementing digital HDTV service in a timely manner. Accordingly, Zenith urges the Commission to continue to establish firm schedules and procedures for HDTV implementation.

Respectfully submitted,

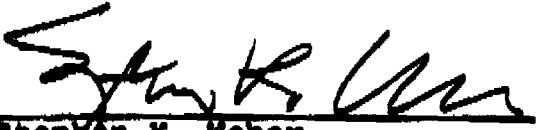
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CERTIFICATE OF SERVICE

I, Stephen K. Weber, hereby certify that a true copy of the foregoing "Reply Comments of Zenith Electronics Corporation" were served this 17th day of August, 1992, by First Class U.S. Mail, postage prepaid, upon the party listed below.


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